Our Reference: UMJ-116-E (UM-2172 p3) PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Ralph T. Yang et al.
Serial Number:	10/726,935
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Examiner/Art Group Unit:	Thuan D. Dang/1764
Title:	SELECTIVE SORBENTS FOR PURIFICATION OF HYDROCARBONS

DECLARATION PURSUANT TO 37 C.F.R. § 1.132

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

I, Ralph T. Yang, hereby declare the following:

1. I am a co-inventor of the above-identified application.

2. I am a citizen of the United States residing at 2627 Pin Oak Drive, Ann Arbor, Michigan 48103.

3. I received a Bachelor of Science in Chemical Engineering from National Taiwan University, Taiwan, in 1964.

4. I received a Master of Science in Chemical Engineering from Yale University, New Haven, Connecticut, in 1968.

5. I received a Ph.D. in Chemical Engineering from Yale University, New Haven, Connecticut, in 1971.

6. I joined the University of Michigan as a professor in the Chemical Engineering Department in 1995. From 1995-2000, in addition to being a professor, I served as Chairman of the Department. In 2002, I was made a Dwight F. Benton Professor, and I currently hold that position at the University.

7. As a professor at the University of Michigan, I have engaged in research in the fields of adsorption, gas separation by adsorption, adsorber dynamics, new sorbent

materials, catalysis (including Environmental Catalysis), NO decomposition, and gas-carbon reactions.

8. From 1978-1995, I worked as a professor in the Department of Chemical Engineering at State University of New York (SUNY) in Buffalo, NY. I joined SUNY in 1978 and worked as an associate professor until 1982. I became a professor in 1982 and a Praxair Professor of Chemical Engineering in 1993. While employed at SUNY, I also served as Chairman of the Department from 1989-1995.

9. After receiving my Ph.D. and prior to working at SUNY, I worked: as a Research Fellow for Argonne National Laboratory in Argonne IL; as a Research Associate in the Department of Chemistry at New York University in New York, NY; as a Scientist in the Physical Chem. Division at Aluminum Company of America in Alcoa Center, PA; as a Chemical Engineer and Group Leader for the Fossil Energy Science Group at Brookhaven National Laboratory in Upton, NY; and then as a Program Director for Separation and Purification Processes, CTS Division at the National Science Foundation in Washington, D.C.

10. I have published two books and over three hundred peer-reviewed journal articles in the field of adsorption and related areas.

11. My research team and I have performed tests on various sorbents to determine the thiophene capacity of each of the sorbents. The tested sorbents include dehydrated sorbents, (such as those disclosed and claimed in the above-identified U.S. Patent Application Serial No. 10/726,935). Specifically, the thiophene capacity of dehydrated Ag-Y and dehydrated Cu-Y were tested.

12. The results from our tests were published in the following papers: A. Takahashi, F. H. Yang and R. T. Yang, "New Sorbents for Desulfurization by Pi-Complexation: Thiophene/Benzene Adsorption," *Ind. Eng. Chem. Res.*, 41, 2487 (2002) **(referred to as "Reference 2")**; A. J. Hernandez-Maldonado and R. T. Yang, "Desulfurization of Liquid Fuels by Adsorption via Pi-Complexation with Cu(I)-Y and Ag-Y Zeolites," *Ind. Eng. Chem. Res.*, 42, 123 (2003) **(referred to as "Reference 3")**; A. J. Hernandez-Maldonado and R. T. Yang, "Desulfurization of Diesel Fuels by Adsorption via Pi-Complexation with Vapor-Phase Exchanged Cu(I)-Y Zeolites," *J. Am. Chem. Soc.*, 126, 992 (2004) **(referred to as "Reference 4")**; and R. T. Yang, A. J. Hernandez-Maldonado and F. H. Yang, "Desulfurization of

Transportation Fuels with Zeolites under Ambient Conditions," *Science*, **301**, 79 (2003) **(referred to as "Reference 5").**

13. I compared our test results with the data published in Michlmayr (U.S. Patent No. 4,188,285; **referred to as "Reference 1").**

14. The following chart identifies the sorbent, the adsorption conditions under which each sorbent was tested, the resulting thiophene capacity (wt%), and the Reference in which the data is published:

Sorbent	Thiophene Capacity (wt%)	Adsorption Conditions	Data Published In
Ag-Y (Michlmayr, not dehydrated)	0.07-0.15	100 ppmw thiophene added to "C_5-C_6" cut of gasoline. Liquid at 22°C.	Reference 1
Ag-USY (Michlmayr, not dehydrated)	0.2	100 ppmw thiophene added to "C_5-C_6" cut of gasoline. Liquid at 22°C.	Reference 1
Ag-Y (dehydrated)	12.6	$2x10^{-5}$ atm, Gas at 120°C	Reference 2
Ag-Y (dehydrated)	7.5	2000 ppmw thiophene in model fuel (n-octane, C_8) Liquid at 22°C.	Reference 3
Cu-Y (dehydrated)	2.4 (as thiophene) or 5.97 (as DBT)*	BP diesel with 297 ppmw S (thiophenes mostly DBT). Liquid at 22°C.	Reference 4
Cu-Y (dehydrated)	2.0 (as thiophene) or 4.97 (as DBT)*	BP gasoline with ~300 ppmw S (thiophenes mostly BT and DBT). Liquid at 22°C.	Reference 5

* Commercial (BP) diesel/gasoline contains mostly benzothiophenes and dibenzothiophenes. For direct comparison, DBT is converted into thiophene based on the same amount of sulfur.

15. As shown in the chart, model fuels were used to test the dehydrated Ag-Y sorbent (2000 ppmw thiophene in model fuel (n-octane, C_8) and the non-dehydrated Ag-Y sorbent (100 ppmw thiophene added to "C_5-C_6" cut of gasoline). Comparing the results, the thiophene capacity of the dehydrated Ag-Y is about 37-180 times higher than that of the non-dehydrated Ag-Y of Michlmayr.

16. The dehydrated sorbents tested and discussed herein are those as described and claimed in the above-identified application.

17. The results indicate that the dehydrated sorbents have a much greater (orders of magnitude greater) capacity for thiophene than the non-dehydrated sorbents of Michlmayr.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under § 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Ralph T. Yang — 7/6/05

Ralph T. Yang — Date